REMARKS/ARGUMENTS

Favorable reconsideration of this application as presently amended and in light of the following discussion is respectfully requested.

Claims 18-28 are pending in the present application. Claim 18 has been amended, Claims 7-17 have been canceled without prejudice, and Claims 22-28 have been added by the present amendment.

In the outstanding Office Action, Claims 7-21 were rejected under 35 U.S.C. § 103(a) as unpatentable over Takeshi et al. (Japanese Patent Application JP 2002-299607, herein "Takeshi") in view of Hamanaka et al. (U.S. Patent No. 6,548,421, herein "Hamanaka") and/or Tanaka (Japanese Patent Application JP 1-102966).

Initially, Applicants note that an Information Disclosure Statement (IDS) has been filed on December 4, 2003, but none of the references listed in the IDS were acknowledged as considered. Accordingly, Applicants respectfully ask the examiner to initialize as considered the PTO-1449 form listing the above noted references. For the examiner's convenience a copy of the PTO-1449 form filed with the IDS and a copy of the date-stamped filing receipt are enclosed herewith.

Regarding the rejection of Claims 7-21 under 35 U.S.C. § 103(a) as unpatentable over Takeshi in view of Hamanaka and/or Tanaka, Claims 7-17 have been canceled and independent Claim 18 has been amended to recite that a first concentration of nitrogen in a surface region of an amorphous insulating layer is 15 atom% or more. The claim amendment finds support in the specification, for example, at page 14, lines 15-25. No new matter has been added.

Briefly recapitulating, amended Claim 18 is directed to a method of manufacturing a semiconductor device. The method includes forming an amorphous insulating layer containing metal, silicon and oxygen on a substrate, and heat-treating the amorphous

insulating layer in a non-oxidizing atmosphere. The amorphous insulating layer has a surface region and a substrate side region. The surface region includes nitrogen of a first concentration which is 15 atom% or more and the substrate side region includes nitrogen of a second concentration that is less than the first concentration. The substrate side region is formed as an epitaxial crystalline insulating layer by a solid-phase growth while the surface region remains an amorphous insulating layer when the heat-treating is applied to the amorphous insulating layer.

In a non-limiting example, Figures 4A-C show the substrate 10, the substrate side region 11a, and the surface region 11b of the amorphous insulating layer 11.

A conventional method forms a High-k insulating film with a poor resistance to impurities and thermally instable as discussed in the specification at page 4, line 22, to page 5, line 2. However, the method of independent Claim 18 provides a High-k insulating film which has an improved thermal stability and also an improved impurity diffusion resistance while making possible to reduce the equivalent oxide thickness of the High-k insulating film and to retain high interfacial properties as disclosed in the specification at page 5, lines 3-13.

More specifically, the specification discloses at page 12, line 16 to page 13, line 8 that a conventional epi-High-k crystalline insulating layer might have a good thermal stability but the layer is defective because the layer is transparent to impurity diffusion because of the crystalline structure. Therefore, the method of independent Claim 18 crystallizes only a part of the insulating layer and preserves as amorphous the part of the insulating layer that is away from the substrate. This two-layer structure of the insulating layer is achieved by the method of Claim 18 by introducing more nitrogen into the surface region of the insulating layer prior to the heat treatment to prevent the crystallization of the surface region during the heat treatment. The specification discloses at page 14, lines 5-10, that "[t]he nitrogen-containing region 11b is capable of obstructing the epitaxial growth of the High-k insulating layer,

thereby preventing the solid phase growth of the High-k insulating layer from further processing beyond the nitrogen-containing region 11b."

However, preventing the surface region of the insulating layer from becoming crystalline is possible if the nitrogen concentration in the surface region is 15 atom% or more as recited in Claim 18 and disclosed in the specification at page 14, lines 18-25. If the concentration of nitrogen is less than 15 atom%, the insulating layer may become fully crystallized in the process of high-temperature treatment, thereby making impossible the realization of a distinct laminate structure of High-k amorphous layer/epi-High-k crystalline layer.

In other words, the method of Claim 18 provides an amorphous insulating layer on a substrate and the insulating layer has (i) a surface region with a first concentration of nitrogen which is 15 atom% or more, and (ii) a substrate side region with a second concentration of nitrogen that is less than the first concentration. After heat is applied to the insulating layer, because of the claimed nitrogen concentrations, the surface region remains amorphous while the substrate side region becomes crystalline. It is also noted that the above structure is obtained when the first concentration of nitrogen is 15 atom % or more in the surface region.

Thus, the method of Claim 18 forms a structure that advantageously achieves an insulating layer that prevents an active region of a MISFET from being contaminated with impurities as disclosed in the specification at page 13, lines 4-8.

Turning to the applied art, Takeshi discloses a metal insulator semiconductor field effect transistor that has a silicon substrate 101, a gate insulating film 103, and a gate electrode 104 formed in this order on the substrate 101 as shown in Figure 4. Takeshi specifically discloses in the abstract, that in "the gate insulation film 103, the content of nitrogen near an interface with the silicon substrate is higher than that in the other parts." In other words, Takeshi clearly requires that a concentration of nitrogen in the insulating film

near an interface with the silicon substrate is higher than "in the other parts" of the insulating film, i.e., a surface region of the insulating film.

On the contrary, Claim 18 recites that the surface region of the insulating layer has a first concentration and the substrate side region has a second concentration and the second concentration is lower than the first concentration.

Accordingly, at least for this reason, Takeshi teaches a nitrogen concentration in an insulation layer that is opposite to what is required by Claim 18.

In addition, amended Claim 18 recites that the first concentration of nitrogen in the surface region of the amorphous insulating layer is 15 atom% or more. Takeshi specifically discloses in paragraph [0023] that "the nitrogen content near the interface with a silicon substrate needs to be less than [0.1atomic%]." Because Claim 18 recites the nitrogen concentration in the *surface region* and Takeshi discloses the nitrogen concentration in the *substrate side region*, it is necessary to determine the nitrogen concentration of the surface region in Takeshi in order to compare the two concentrations. This is possible based on the enclosed reference of Sekine (Nitrogen Profile Control by Plasma Nitridation Technique for Poly-Si Gate HfSiON CMOSFET with Excellent Interface Property and Ultra-low Leakage Current). Referring to Figure 10(b) of Sekine, it is noted that Figure 10(b) shows an insulating layer of HfSiON formed on a Si substrate and the nitrogen concentrations of the two layers. As explained in the enclosed Declaration Under 37 C.F.R. § 1.132 of Mr. M. Koyama, one of the inventors of this application, Figure 10(b) of Sekine shows that a concentration of nitrogen less than 0.1 atom% in a region near the interface with the silicon substrate (as required by Takeshi) cannot be obtained if the nitrogen concentration in the surface region of the insulating layer is 15 atom% or more.

In other words, Applicants respectfully submit that to obtain a 0.1 atom% concentration of nitrogen in the substrate side of the insulating layer as requested by Takeshi

in paragraph [0023], it is necessary that a concentration of nitrogen less than 15 atom% is provided in the surface region of the insulating layer, which is contrary to Claim 18. Thus, Applicants respectfully submit that amended Claim 18 is different from Takeshi.

The outstanding Office Action relies on Hamanaka or Tanaka for disclosing a heating treatment step that lacks in Takeshi. However, neither Hamanaka nor Tanaka cures the deficiencies of Takeshi discussed above.

Therefore, because neither of the applied art teaches or suggests (i) the first concentration of nitrogen in a surface region of an insulating layer being higher than a second concentration of nitrogen in a substrate side portion of the insulating layer, and (ii) the first concentration of nitrogen in the surface region of the insulating layer being 15 atom% or more, Applicants respectfully submit that amended Claim 18 and each of the claims depending therefrom patentably distinguish over the applied art.

New Claims 22-28 have been added to set forth the present invention in a varying scope and Applicants respectfully submit the new claims find support in the originally filed specification. New Claims 22-28 depend directly or indirectly from independent Claim 18, which is believed to be allowable as noted above. Accordingly, it is respectfully submitted that dependent Claims 22-28 are also allowable.

Consequently, in light of the above discussion and in view of the present amendment, the present application is believed to be in condition for allowance and an early and favorable action to that effect is respectfully requested.

Respectfully submitted,

OBLON, SPIVAK, McCLELLAND,
MAIER & NEUSTADT, P.C.

R Fetea

Eckhard H. Kuesters
Attorney of Record
Registration No. 28,870
Remus F. Fetea, Ph.D.
Limited Recognition No. L0037

Customer Number
22850

Tel: (703) 413-3000
Fax: (703) 413 -2220
(OSMMN 06/04)

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